

# Aerosol Challenge Technology and Applications in Biodefense

## **“Biological Safety”**

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# Guidelines/Management Documents Applicable to RBLs and NBLs

- NIH Grants Policy Statement 03/01/01 Part II  
Subpart B (Construction Grants)
- NIH Design and Policy Guidelines
- Biosafety in Microbiological and Biomedical  
Laboratories  
CDC/NIH 4<sup>th</sup> Ed.
- Primary Containment for Biohazards: Selection,  
Installation and Use of Biological Safety Cabinets  
CDC/NIH Appendix A of the BMBL

# Guidelines/Management Documents Applicable to RBLs and NBLs

- Guide for the Care and Use of Laboratory Animals, National Research Council, National Academy Press, Washington D.C.
- Select Agent Rule and Related Matters  
CDC

# Guidelines/Management Documents Applicable to RBLs and NBLs

- NIH Model Commissioning Guide
- Public Disclosure – National Environmental Policy Act (NEPA)
- Life Safety Guide – National Fire Protection Association (NFPA) Pub 101
- Prudent Practices for Safety in Laboratories (1595) – National Research Council
- National Sanitation Foundation Standard No. 49 for Class II (Laminar Flow) Biohazard Cabinetry
- USDA Agriculture Research Service 242.1

# Functions: Equipment and Facility + Practices

- Protect Employees
- Protect Experimental Materials
- Protect Research Animals
- Protect Environment

# Facilities

- BSL-1, 2, 3, 4
- Animal BSL-1, 2, 3, 4
- Agricultural – BSL-1, 2, 3, 4 Ag.

# Special Considerations

- Comprehensive Medical Surveillance Program
  - Pre Screening (Initial Physical)
  - Immunization
  - Follow-up All Employee Illnesses
  - Terminal Physical Examinations

# Selection + Use Personnel Protective Equipment

- Clothing Change – Laboratory Garments
- Respiratory Protections
  - Full Face Respirators
  - Half Suites
  - Ventilated Plastic Full Length Suites
- Eye Protection
- Selection and Use of Gloves



# Training

- All Encompassing
- Laboratory Manipulations
- Protocols
- Procedures
- Practices
- Decontamination
- Equipment Usage
- Animal Care and Use

# Aerosol Challenges

- BSL-3, 4 Facilities
- Primary Barriers – Biological Safety Cabinets

Aerosol Chambers

Henderson Apparatus

# Type Challenges

- Liquid Suspensions
- Dried Microorganisms

# Challenge Methods

- Nose Dropper
- Micro Pipettes
- Oral Feeding Tubes
- Nose + Mouth Only
- Head Only
- Whole Body

# Special Animal Handling Requirements

- Caging – Transport

Exposure

Long Term Holding

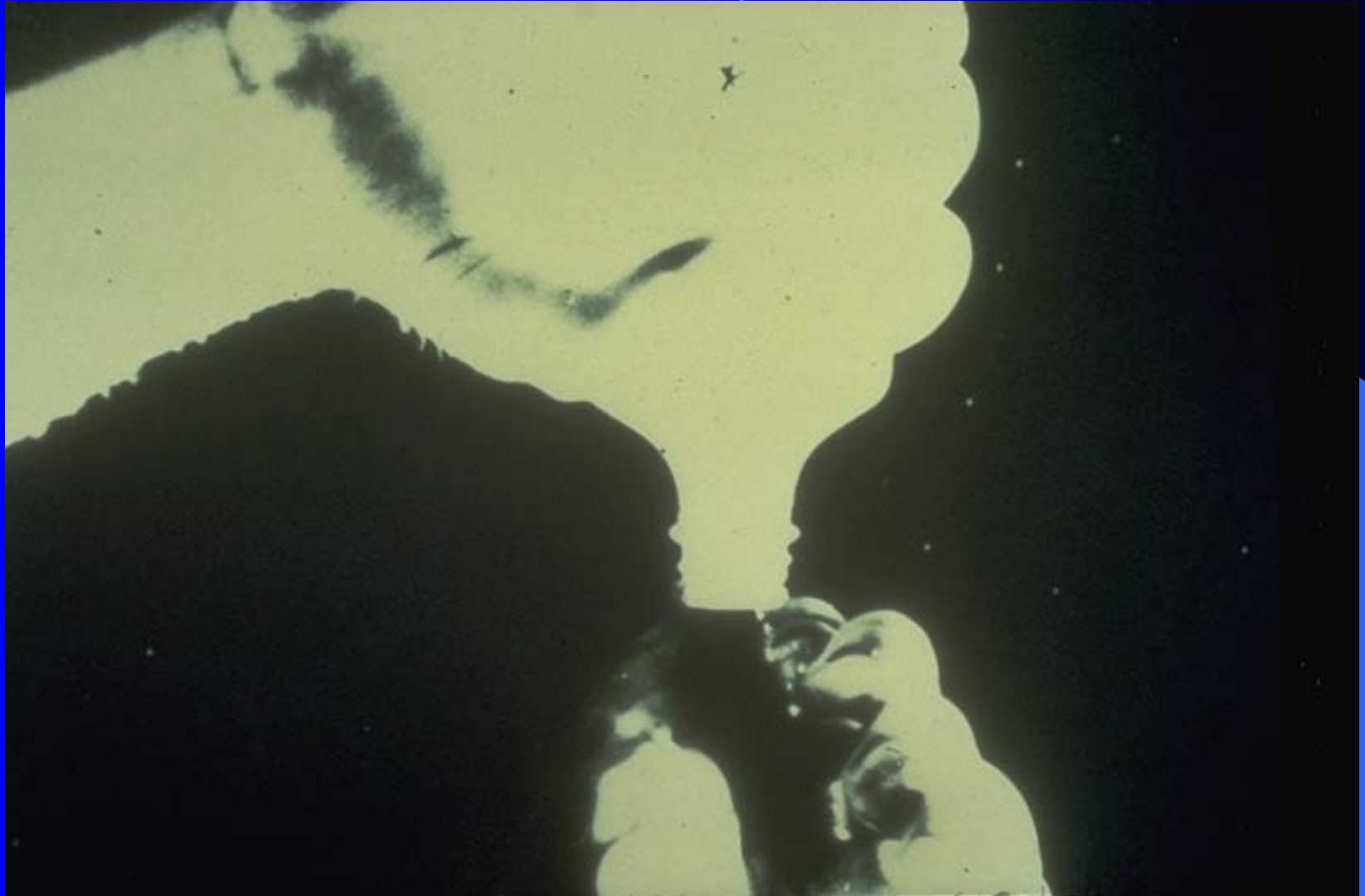
Examination

# Aerosols From Laboratory Manipulations

# Episodes of Single-source, Multiple Laboratory Infections

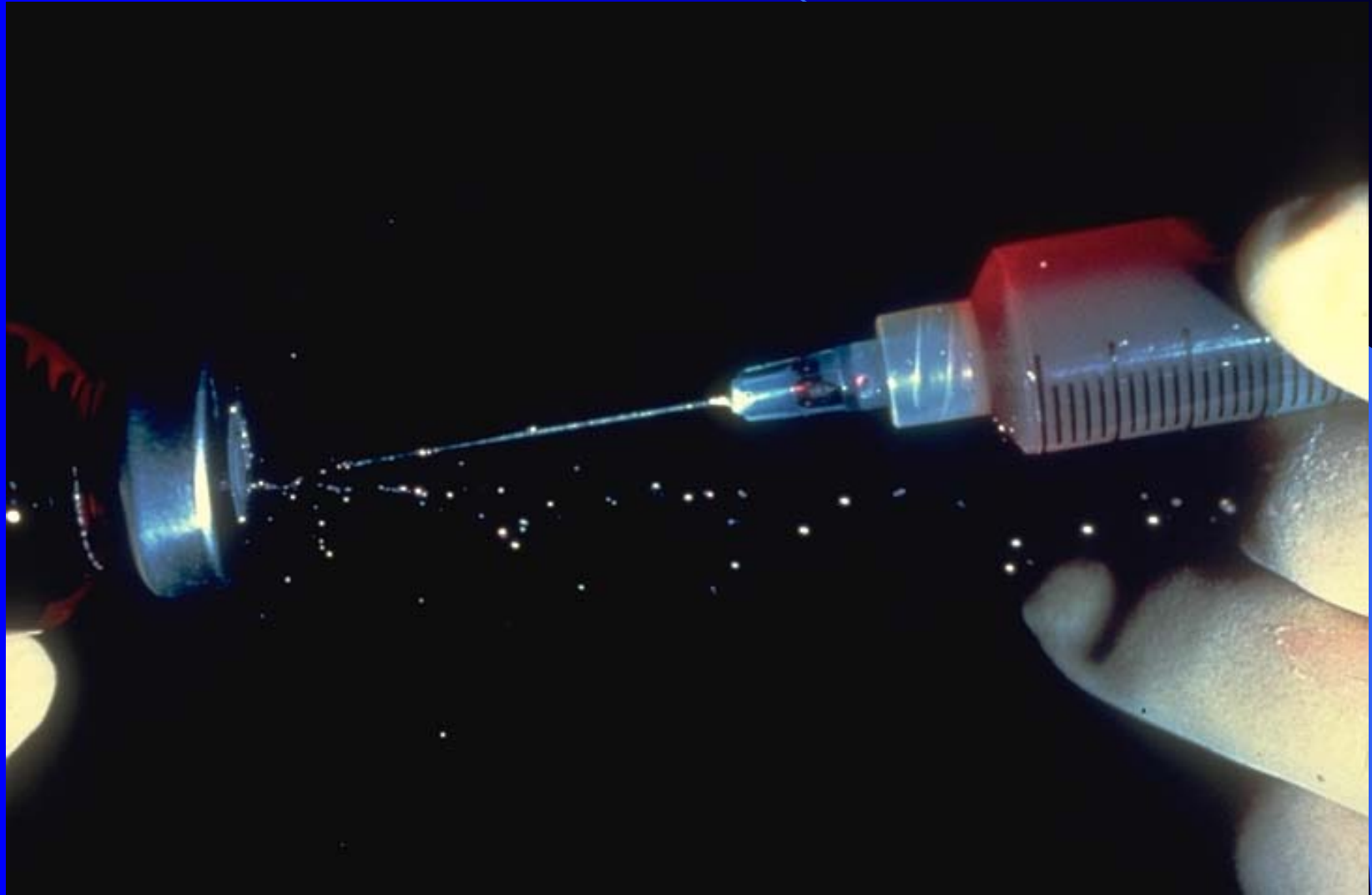
<b>Disease</b>	<b>Probable Source of Infection</b>	<b>Maximum Distance From Source</b>	<b>Number Persons Infected</b>
<b>Brucellosis</b>	<b>Centrifugation</b>	<b>Basement To 3<sup>rd</sup> floor</b>	<b>94</b>
<b>Coccidioidomycosis</b>	<b>Culture transfer solid media</b>	<b>2 Building floors</b>	<b>13</b>
<b>Coxsackie Virus infection</b>	<b>Spilled tube of infected mouse tissue on floor</b>	<b>5 feet (estimated)</b>	<b>2</b>
<b>Murine Typhus</b>	<b>Intranasal inoculation of mice</b>	<b>6 feet (estimated)</b>	<b>6</b>
<b>Tularemia</b>	<b>20 petri plates dropped</b>	<b>70 feet</b>	<b>5</b>
<b>Venezuelan encephalitis</b>	<b>9 lyophilized ampoules dropped</b>	<b>4<sup>th</sup> floor stairs to 3<sup>rd</sup> or 5<sup>th</sup></b>	<b>24</b>

# Opening A Container





# Withdrawing A Needle From A Vaccine Bottle



# Vortex Mixing



# Pipette: Blowing Out The Last Drop



# Opening A Centrifuge Cup



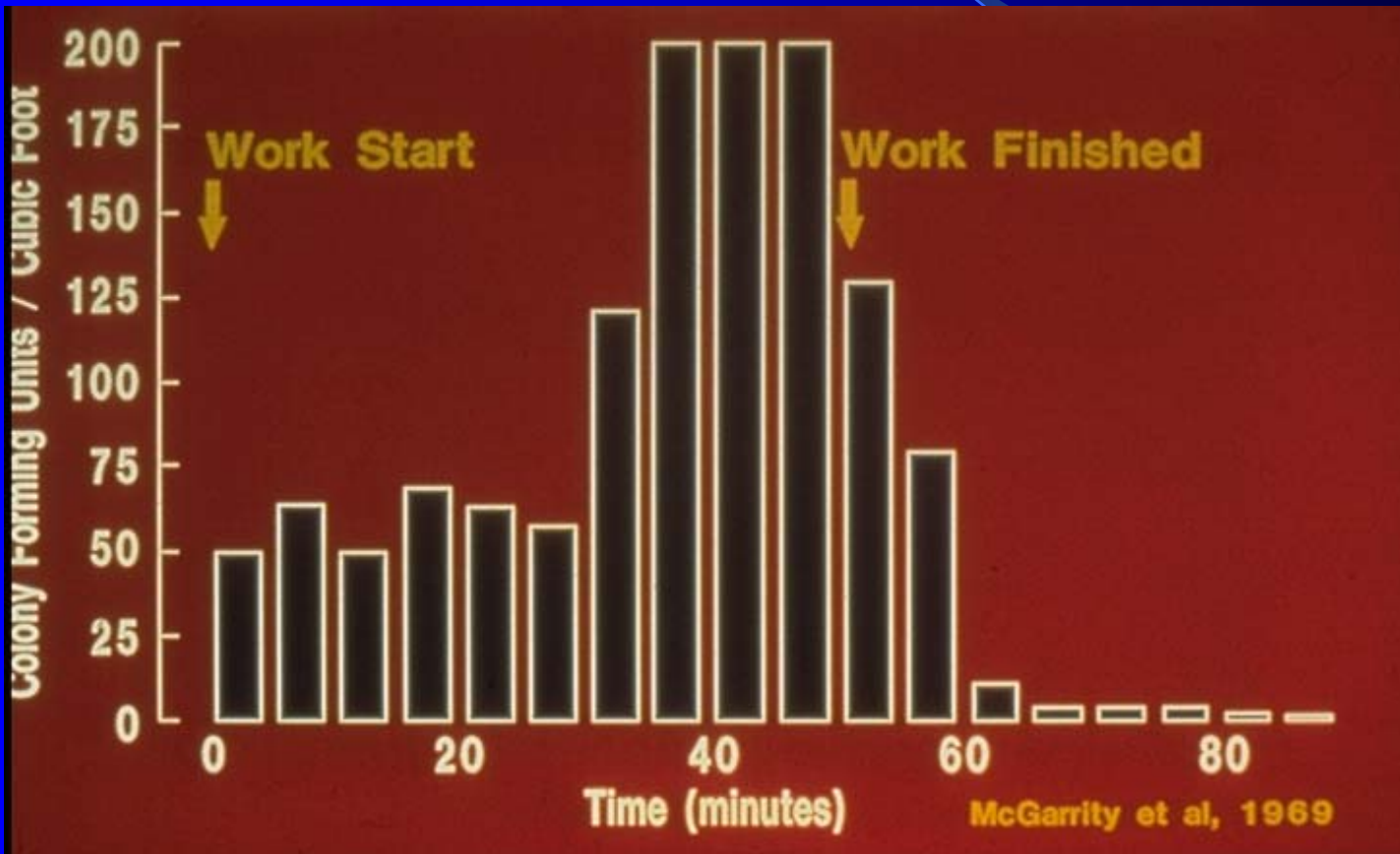
# AEROSOLS FROM LAB EQUIPMENT

( $10^{10}$ /ml culture – 10 min. use)

Blender, opened at once	$10^6$
Sonicator, with bubbling	$10^6$
Pipetting, vigorous	$10^6$
Dropping culture	$3 \times 10^5$
Splash on centrifuge rotor	$10^5$
Drop spill on zonal rotor	$2 \times 10^4$
Blender, opened at 1 minute	$2 \times 10^4$
Pipetting, carefully	$10^4$



# Aerosols from Animal Cage Cleaning



# Factors Affecting Survival of Aerosolized Organisms

- Environmental-temperature, relative humidity
- Suspending Medium – pH, specific gravity, constituents, e.g. protein
- Surface – Porous vs. non-porous

# Factors Affecting Character of Aerosols

## Energy Input

Low – Large particles

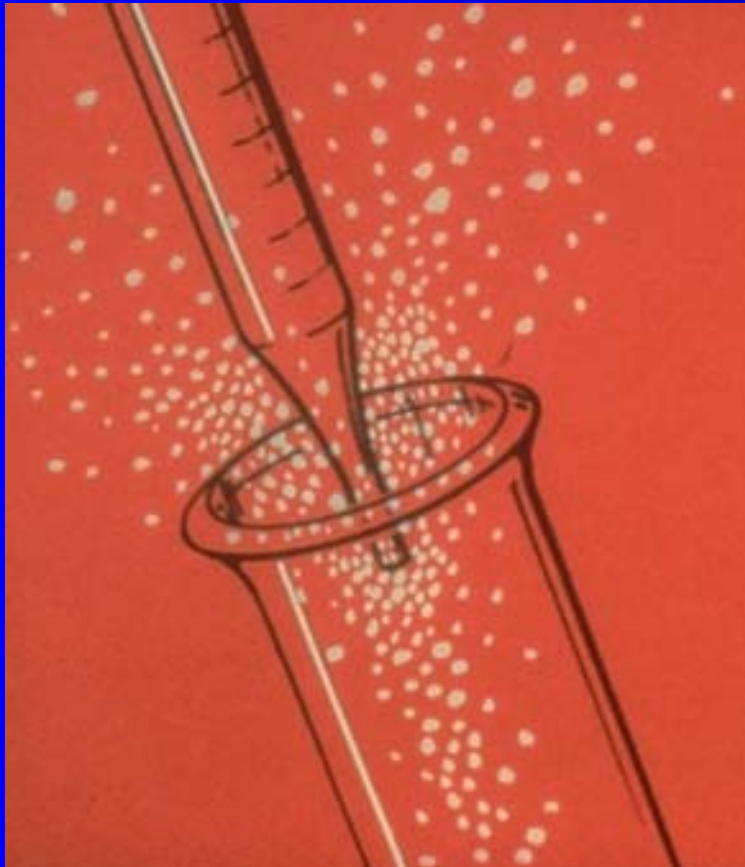
High – small particles

Infectious Units/Particle –  
organisms/unit, volume of  
original suspension

Persistence-particle size



# Estimated Small Particle Aerosol Dose from Pipetting $10^{10}$ /ml - min



- At 3 feet 1,200
- At 10 feet 50

Dimmick 1973 et. al.,

# Estimated Small Particle Aerosol Dose from Blender

10<sup>10</sup>/ml –  
5 min



- At 3 feet 2,000
- At 10 feet 200

Dimmick 1973 et. al.,

# Summary

- Facility – Planning
  - Construction
  - Operation + Use
  - Maintenance
- Adopt Good Policies, Procedures, Practices
- Select Challenge Method
- Institute Proper Animal Care and Use
- Institute Personnel Wellness Program
  - Medical Surveillance Program
  - Personnel Protective Equipment